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ABSTRACT

In the operation of vacuum filters and belt filters, it is desirable to evaluate the performance of different types of filter media and conditioning processes. The filter leaf test, which is used to evaluate these items, is described. Designed for individuals who have completed National Pollutant Discharge Elimination System (NPDES) level 1 laboratory training skills, this module provides waste water treatment plant operators with the basic skills and information needed to: (1) successfully run the filter leaf test; (2) accurately record data and observations; (3) organize data to perform the required calculations for the test; (4) make general interpretations as to the quality of the sludge used in the test and of the media used on the filter; and (5) obtain reliable and consistent results. The instructor's manual contains a statement of instructional goals, lists of instructor/student activities and instructional materials, overhead transparency masters of filter leaf apparatus, and student worksheet (with answers). The student workbook contains objectives, prerequisite skills needed before the module is started, laboratory procedures, and worksheet. (Author/JN)

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Operational Control Tests

for Wastewater Treatment Facilities

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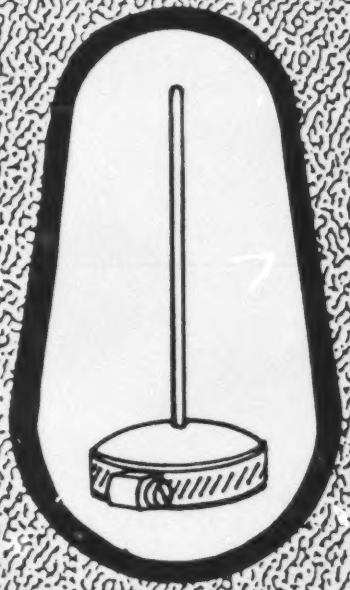
Filter Leaf

Instructor's Manual



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Linn-Benton Community College
Albany, Oregon

FILTER LEAF TEST

Written By:
John F. Wooley
Linn-Benton Community College
Albany, Oregon

Instructional Design:
Priscilla Hardin
Corvallis, Oregon

Project Management:
John W. Carnegie, Ph.D.
Linn-Benton Community College
Albany, Oregon

Project Officer:
Lynn S. Marshall
United States Environmental Protection Agency
National Training and Operational Technology Center
Cincinnati, Ohio

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FILTER LEAF TEST

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INSTRUCTIONAL GOALS

Upon completion of this lesson the student should be able to successfully run the filter leaf test and accurately record the data and observations. The student also should be able to organize the data so as to perform the required calculations for this test. Based on values obtained the student should be able to make general interpretations as to the quality of the sludge utilized in the test and of the media used on the filter.

INSTRUCTOR ACTIVITY

For best results follow this sequence:

	Activity	Time
1.	Review the objectives with the students.	5 minutes
2.	Have students read the procedure.	10 minutes
3.	Demonstrate the test procedure.	15 minutes
4.	Discuss calculations.	15 minutes
5.	Assign worksheet.	5 minutes
6.	Correct worksheet.	10 minutes
7.	Perform test.	30 minutes
8.	Perform calculations and make interpretations.	20 minutes

OTHER ACTIVITIES:

1. Clarify information needed for calculations.
2. Have students calculate filter rate and other pertinent parameters based on pre-collected test data. Other parameters include percent solids and percent moisture.

STUDENT ACTIVITY

1. Read objectives.
2. Read procedure.
3. Complete worksheet.
4. Perform test.
5. Record data.
6. Perform calculations.
7. Interpret results.

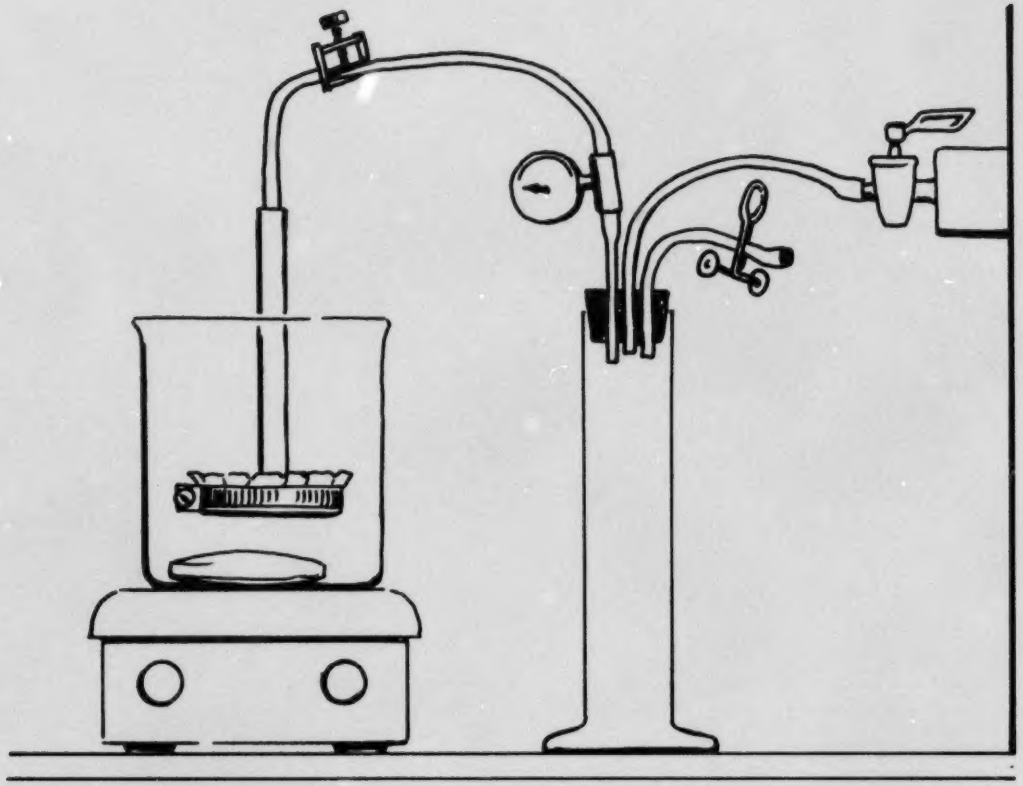
INSTRUCTIONAL MATERIALS LIST

1. Instructor's Guide - Filter Leaf
2. Students Workbook - Filter Leaf
3. Overhead projector
4. Projection screen
5. Equipment listed in the lab procedures

APPENDIX A - Overhead #1

Illustration of Filter Leaf Apparatus.

OH #1



WORKSHEET

Directions: Place an "X" by the best answer. There is only one best answer for each question.

1. The purpose of the filter leaf test is to:

   a)_____find the concentration of mixed liquid.
   b)__X__evaluate filter media and conditioning processes.
   c)_____determine sludge viscosity.
   d)_____simulate the compacting reached in a clarifier.
   e)_____None of the above.

2. The filter leaf test is based on an assumption that:

   a)__X__the leaf is a prototype of a vacuum filter.
   b)_____ultimate settleability takes place.
   c)_____the sludge is stable.
   d)_____the sludge is inorganic.
   e)_____None of the above.

3. The parts of a vacuum filter cycle are:

   a)_____settleability, separation, compaction.
   b)__X__submergence, drying, off filter.
   c)_____cake dry weight, cake wet weight, and % solids in sludge.
   d)_____All of the above.
   e)_____None of the above.

4. The filter rate is reported in:

   a)_____ppm.
   b)_____ml/ml
   c)_____lbs/gal
   d)__X__lb/hr/ft^2
   e)_____None of the above.

5. Given the dry cake weight (CDW) is 35.4136 g, 30 cycles per hour of the vacuum filter and a leaf area of 0.085 ft^2 the filter rate is:

a)_____ 2.753 lbs/hr/ft^2.

b)__X__ 27.53 lbs/hr/ft^2.

c)_____ 0.2753 lbs/hr/ft^2.

d)_____ 275.3 lbs/hr/ft^2.

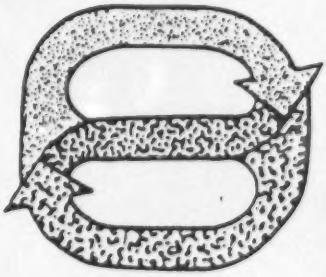
e)_____ None of the above.

Operational Control Tests

for Wastewater Treatment Facilities

Filter Leaf

Student Workbook



Linn-Benton Community College
Albany, Oregon

SE039204

FILTER LEAF TEST

Written By:
John F. Wooley
Linn-Benton Community College
Albany, Oregon

Instructional Design:
Priscilla Hardin
Corvallis, Oregon

Project Management:
John W. Carnegie, Ph.D.
Linn-Benton Community College
Albany, Oregon

Project Officer:
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FILTER LEAF TEST

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INTRODUCTION

This lesson on the filter leaf test will provide the operator with the basic information needed to obtain reliable and consistant results. The mention of any brand names should not be taken as an endorsement of that material.
This material is intended to be used by individuals who have completed NPDES level I laboratory skills training.

OBJECTIVES

Upon completion of this module you should be able to:

1. Describe the purpose of the test.
2. Calculate the filter rate.
3. Describe the equipment necessary to run the test.
4. Perform the test procedure.

PREREQUISITE SKILLS

In addition to the skills listed in the introduction the following skills are needed for this test:

1. Familiarity with the use of vacuum equipment.
2. Ability to use a timer clock.
3. Ability to accurately use an analytical balance.

RESOURCE LIST

Filter leaf apparatus may be purchased from:

1. EIMCO Processing Machinery Division
   Envirotech Corp.
   669 West Second South
   Salt Lake City, Utah 84110

FILTER LEAF TEST

INTRODUCTION

In the operation of vacuum filters and belt filters it is desirable to evaluate the performance of different types of filter media and conditioning processes. The filter leaf tests is used to evaluate these items. In a typical cycle of a vacuum filter the filter media spends 30 seconds submerged, 60 seconds drying under vacuum but not submerged, and 30 seconds not in contact with the filter. In other words, 25% of the filter drum circumference is submerged and 25% is not covered by fabric. Sludge drying occurs on only 50% of the filters circumference.

This cycle can be simulated with a filter leaf. The filter consists of a round disc 10 cm in diameter, over which a filter medium is stretched. This disc is connected to a vacuum source through a graduated cylinder used to collect filtrate. The filter leaf covered with media is placed into a beaker of sludge and held there for 30 seconds. The filter leaf is then removed from the sludge and the vacuum is continued for 60 seconds to simulate the drying cycle. The vacuum is then turned off. The cake is scraped off and analyzed for solids content and the total dry cake solids produced is calculated. The filtrate is analyzed for suspended solids, allowing calculations of solids recovery to be performed. The diameter of the filter leaf is measured and used in determination of surface area of filter leaf. This information is used in the calculation of filter yield.

Variations of the filter leaf test can also be used to test filter media used on belt filters.

EQUIPMENT

1 liter graduated cylinder

2 liter beaker

Magnetic stirrer with stirring bar

Filter leaf (10 cm diameter)

Filter media

Vacuum source

Vacuum gauge

Quick opening valves

Lab timer

PROCEDURE

1. PLACE FILTER MEDIA OVER HOLDER.

   Stretch filter media over the filter leaf. This media is held in place with a hose clamp. (See diagram at end of procedure.)

   CAUTION: The first two or three tests with a new cloth media should be discarded as they will not be an accurate indication of fabric performance.

2. ATTACH FILTER LEAF TO VACUUM SOURCE.

   The filter leaf is attached to a vacuum gauge. This whole assembly is then inserted through a 3-hole stopper of sufficient size to fit a 1 liter graduated cylinder. In the other two holes of the stopper vacuum hoses are inserted. One is the primary vacuum line, the other has a quick opening valve attached which can be opened or closed to adjust the amount of vacuum in the system.

3. PREPARE SAMPLE.

   In a 2 liter beaker, place 1500 ml of well mixed chemically conditioned sludge.

   Various dosages and types of conditioning chemicals can be tried at this point. Refer to Jar Test procedure for chemical preparation and suggested procedure for testing chemical dosage.

4. MIX SAMPLE.

   Insert stirring bar in the beaker. Place beaker on magnetic stirrer. Mix at medium speed setting.

5. RUN PERCENT SOLIDS TEST

   on the mixed, conditioned sludge. Refer to procedure in Supplementary Materials.

6. PLACE FILTER LEAF IN SAMPLE.

7. TURN ON VACUUM.

   Hold filter leaf in sludge for 30 seconds with

vacuum on. Vacuum reading should approximate that of actual plant filter equipment. The vacuum times should also be adjusted to approximate the actual plant filter.

8. REMOVE FILTER LEAF FROM SAMPLE.

   The filter leaf is removed from sample. The vacuum is left on for one minute to simulate drying time of plant filter. If the actual filter cycle differs adjust the vacuum and drying time to match the plant filter.

9. TURN OFF VACUUM.

10. SCRAPE CAKE FROM FILTER LEAF.

    Scrape cake from filter leaf into a pre-weighed evaporating dish.

11. WEIGH THE WET CAKE.

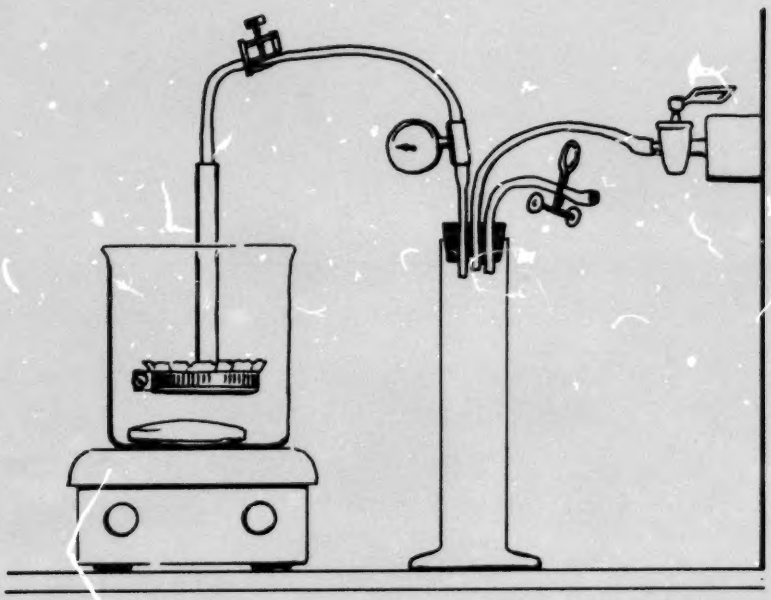
    Weigh the wet cake and the pre-weighed dish to four decimal places. Record this value on data sheet as dish plus wet cake.

12. DRY AND WEIGH THE CAKE.

    Dry cake in the dish in a 103°C. oven for 1 hour. Cool and weigh to four decimal places. Record this value on data sheet as dish plus dry cake.

13. EXAMINE FILTRATE.

    Record the volume of filtrate collected in the 1 liter graduate. Determine suspended solids in filtrate.



FILTER LEAF APPARATUS SET-UP

CALCULATIONS

Percent Solids in Conditioned Sludge

(Refer to Percent Solids Procedure in Supplementary Materials.)

Wet Cake Weight

Wet Cake, g = (Dish plus Wet Cake, g) minus (Dish weight, g)

Example:

Dish plus Wet Cake = 262 g

Dish weight = 180 g

Wet Cake, g = (262 g) - (180 g)

= 82 g

Dry Cake Weight

Dry Cake, g = (Dish plus Dry Cake, g) minus (Dish weight, g)

Example:

Dish plus Dry Cake = 208 g

Dish weight = 180 g

Dry Cake, g = (208 g) - (180 g)

= 28 g

Percent Solids in Wet Cake

$$\% \text{ Solids, wet cake} = \frac{\text{Dry Cake, g}}{\text{Wet Cake, g}} \times 100\%$$

Example:

Dry Cake, g = 28 g

Wet Cake, g = 82 g

$$\% \text{ Solids, wet cake} = \frac{28 \text{ g}}{82 \text{ g}} \times 100\%$$

$$= 34\%$$

$$\text{Filter Rate} = \frac{\text{Dry Cake, g X cycles/hour}}{\text{454 g/lb X 0.085 ft}^2}$$

$$= \text{lbs/hr/ft}^2$$

Example:

Dry Cake, g = 28 g

Cycles/hour = 2 minutes/cycle or 30 cycles/hr

$$\text{Filter Rate} = \frac{\text{28 g X 30 cycles/hr}}{\text{454 g/lb X 0.085 ft}^2}$$

$$= 21.8 \text{ lbs/hr/ft}^2$$

CONCLUSION:

There are many varieties of filter media available. The coarser media will usually give drier cake, but at the expense of passing fine suspended material to the filtrate. The filter leaf test can be used to determine the "best" medium for a particular sludge or specific application.

The filter leaf test allows for evaluation of various types and dosages of chemical conditioners. Modification in conditioning methods, drum speed, and amount of vacuum applied can be made in response to the filter leaf test results.

By comparing solids in conditioned sludge (in percent) to the solids in the wet cake (in percent) as estimation of filter efficiency can be made. Determination of the weight of dry cake produced leads to calculation of the filter rate. The value establishes a target for the actual plant equipment and an estimation of the amount of solids being discharged.

SUPPLEMENTARY MATERIAL

INTRODUCTION

In order to properly set pumping rates in a wastewater plant, operators must know how much water a given volume of sludge contains. The test is a modification of the total solids test.

EQUIPMENT

Porcelain evaporating dish - 100 ml or 200 ml
Balance - accurate to 0.1 g
Drying oven set at 103°C.
Steam table

PROCEDURE

1. CLEAN PORCELAIN DISH.

   Use acid cleaning solution and rubber gloves. Residues are difficult to remove and may have to be scrubbed out with steel wool. Wash in hot, soapy water and rinse thoroughly with final rinse in distilled water.

2. PLACE DISH IN 103°C. OVEN.

   Leave dishes in oven until ready to use.

3. USING DISH HOLDER, REMOVE DISH FROM OVEN.

   Allow it to cool on asbestos pad for 15 minutes.

4. WEIGH DISH.

   Weigh to nearest 0.1 g and record as dish weight.

5. MIX SLUDGE SAMPLE WITH GLASS ROD.

   Add well-mixed sample to dish until dish is 2/3 full.

6. RE-WEIGH DISH AND SAMPLE TO NEAREST 0.1 g.

   By subtracting, find weight of sample.

7. PLACE DISH ON STEAM TABLE.

Table should be producing steam before dish is placed in position. Remove two or three rings to allow dish to sit down in table. Make sure water is running through table and that the overflow tube is functioning. CAUTION: Do not let table run out of water or heating element may be burned out.

8. REMOVE DISH AND WEIGH.

After the water in the sample has evaporated, remove the dish, dry off the outside of the dish, and weigh to the nearest 0.1 g. Record as dish plus residue weight.

9. PLACE DISH IN ACID BATH TO SOAK.

CALCULATIONS

$$\% \text{ Solids} = \frac{\text{Residual weight}}{\text{Sample weight}} = 100$$

Example:

A. Dish weight = 112.5 g

B. Dish weight plus sample = 272.3 g

C. Dish weight plus residue = 126.2 g

Sample weight = (b - a) = 272.3 - 112.5 = 159.8 g

Residue weight = (c - a) = 126.2 - 112.5 = 13.7 g

$$\% \text{ Solids} = \frac{13.7 \text{ g}}{159.8 \text{ g}} \times 100$$

$$= 8.6\%$$

FILTER LEAF TEST DATA

Sample Data				Chemicals Added, mg/l					Cake Weights, g							
				1	2	3	4	5								
Sample No.	Sample Location	Sample Time	Collected By						Dish Plus Wet Cake	Dish	Wet Cake	Dish Plus Dry Cake	Dry Cake	% Solids in Dry Cake	Filtrate Vol	Filtrate S.S.

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3/82

SAMPLE DESCRIPTION

USE TO CALCULATE CAKE WEIGHTS

SAMPLE DATA SHEET

FILTER LEAF TEST DATA

Sample Data				Chemicals Added, mg/l					Cake Weights, g							
				1	2	3	4	5								
Sample No.	Sample Location	Sample Time	Collected By	FeCl3					Dish Plus Wet Cake	Dish	Wet Cake	Dish Plus Dry Cake	Dry Cake	% Solids in Dry Cake	Filtrate Vol	Filtrate S.S.
1	mixing tank	9:15 a	JWC	80					262	180	82	208	28	34	87 mL	43 %

NAME AND AMOUNT OF CHEMICALS ADDED

DATA USED TO EVALUATE TEST

PROCEDURE SUMMARY

PROCEDURE

1. Place new filter media over holder
2. Attach holder to vacuum source
3. Prepare and mix sample
4. Run % Solids on sludge
5. Put filter leaf into sludge
6. Turn on vacuum
7. Remove filter leaf from sludge
8. Turn off vacuum
9. Scrape cake from filter leaf
10. Weigh cake
11. Dry and weigh cake (CDW)
12. Examine filtrate

CALCULATIONS

Filter Rate

$$F.R. = \frac{CDW \times cycle/hr}{454\ g/lb \times 0.085\ ft^2}$$

$$= lb/hr/ft^2$$

Filter Leaf Test

The above procedure summary is designed as a laboratory aid. It may be cut out and attached to a 5" X 7" index card for convenient reference at the laboratory bench. To protect the card you may wish to cover it, front and back, with clear, self-adhesive shelf paper or similar clear material.

WORKSHEET

Directions: Place an "X" by the best answer. There is only one best answer for each question.

1. The purpose of the filter leaf test is to:

   a)_____find the concentration of mixed liquid.
   b)_____evaluate filter media and conditioning processes.
   c)_____determine sludge viscosity.
   d)_____simulate the compacting reached in a clarifier.
   e)_____None of the above.

2. The filter leaf test is based on an assumption that:

   a)_____the leaf is a prototype of a vacuum filter.
   b)_____ultimate settleability takes place.
   c)_____the sludge is stable.
   d)_____the sludge is inorganic.
   e)_____None of the above.

3. The parts of a vacuum filter cycle are:

   a)_____settleability, separation, compaction.
   b)_____submergence, drying, off filter
   c)_____cake dry weight, cake wet weight, and % solids in sludge.
   d)_____All of the above.
   e)_____None of the above.

4. The filter rate is reported in:

   a)_____ppm.
   b)_____ml/ml
   c)_____lbs/gal
   d)_____$lb/hr/ft^2$
   e)_____None of the above.

5. Given the dry cake weight (CDW) is 35.4136 g, 30 cycles per hour of the vacuum filter and a leaf area of 0.085 ft^2 the filter rate is:

a)_____2.753 lbs/hr/ft^2.

b)_____27.53 lbs/hr/ft^2.

c)_____0.2753 lbs/hr/ft^2.

d)_____275.3 lbs/hr/ft^2.

e)_____ None of the above.